# Hydrogen Technology Validation as a "Learning Demonstration" that Feeds the R&D Process

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# Outline

- Technology Validation Strategy and Targets
- Role of Technology Validation in DOE's Hydrogen, Fuel Cells, & Infrastructure Technologies Program
- Competitive Solicitation Background
- Summary of Winners Announced
- Data to Be Collected by Industry
- Planned Data Analysis
- Future Work

# Technology Validation Strategy

- To conduct learning demonstrations that emphasize co-developing hydrogen infrastructure in parallel with hydrogen fuel cell-powered vehicles to **allow a commercialization decision by 2015**.
  - Test, demonstrate, and validate optimum system solutions
  - Refocus Hydrogen R&D Program as appropriate

# Controlled Fleet Performance Targets
## (From solicitation RFP, Appendix C)

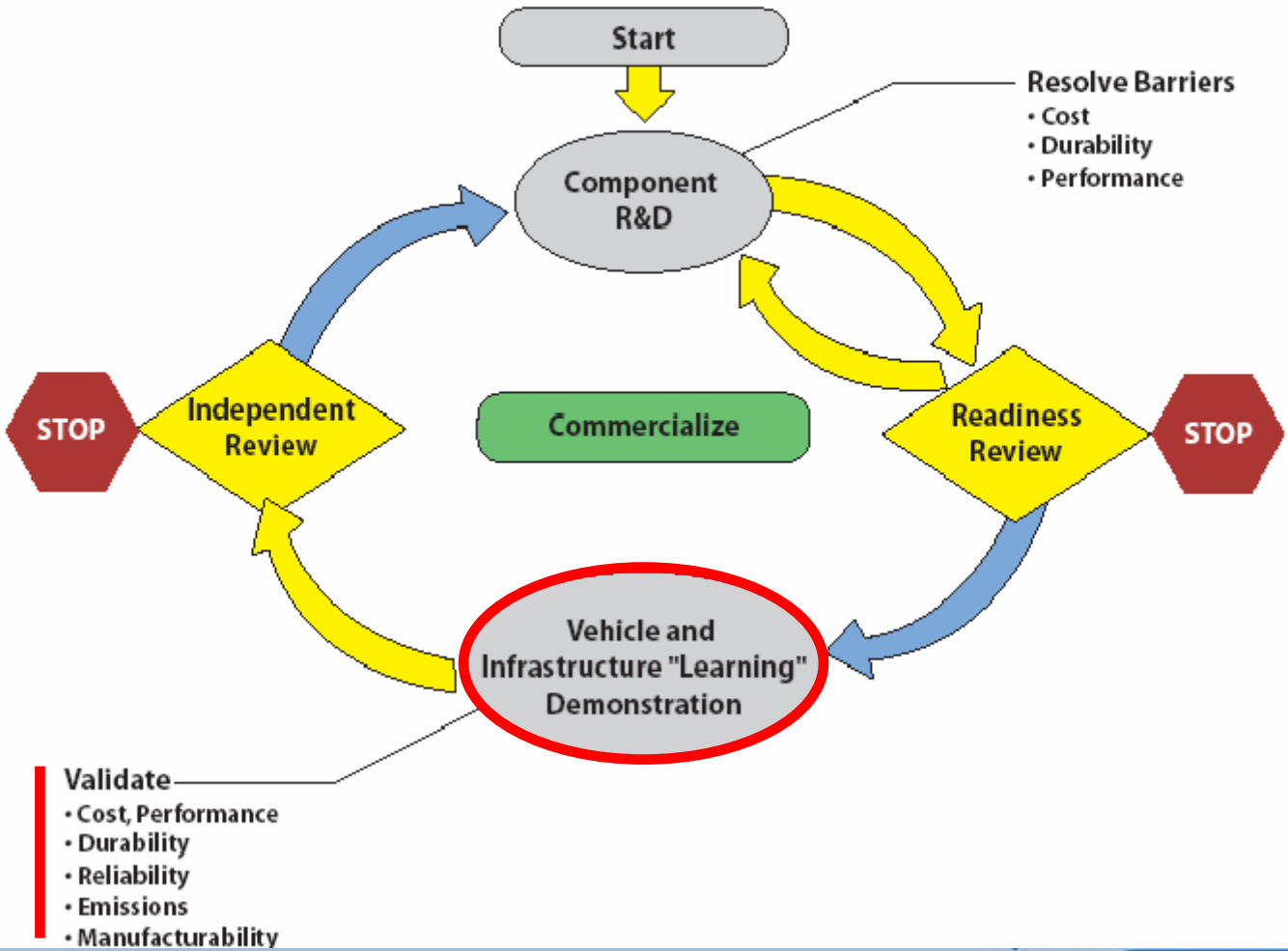
- 2008 Performance Targets
  - FC Stack Durability: 2000 hours
  - Vehicle Range: 250+ miles
  - H2 cost at station: $3.00/kg
- 2015 Performance Targets
  - FC Stack Durability: 5000 hours
  - Vehicle Range: 300+ miles
  - H2 cost at station: $1.50/kg

To verify progress toward 2015 targets

Subject of subsequent projects to validate 2015 targets

# Role of Technology Validation in the DOE's Hydrogen R&D Process

Figure 3.5.1. The Role of Technology Validation—
*"Learning demonstration activity with clearly defined objectives, milestones, and go/no-go decisions"*



# Controlled H2 Fleet & Infrastructure Solicitation: General Information

- Five year project 2004 – 2009
- Government/industry cost shared co-operative agreement
- $150M –$240M Government share subject to the appropriations process
  - $190M announced this week
- Data from project to help refocus R&D projects
- 2 Generations of vehicles
- Cold climates to be included by 2nd generation
- Must include renewable feedstock for H2 generation
- Codes, Standards and Education integral to the success of the project
- Stationary facilities that co-produce electricity and hydrogen are encouraged

SOLICITATION FOR SUBMISSION OF FINANCIAL ASSISTANCE APPLICATIONS

OFFICE OF ENERGY EFFICIENCY AND RENEWABLE ENERGY

SOLICITATION NUMBER DE-PS36-03GO93030

CONTROLLED HYDROGEN FLEET AND INFRASTRUCTURE DEMONSTRATION AND VALIDATION PROJECT

# Project Safety – Key Part of Project

- Solicitation bidders required to include in their proposal:
  - Preliminary Failure Modes and Effects Analysis (FMEA) on the project
  - Brief example of safety assessment
  - Detailed outline of Risk Mitigation Plan
  - Description of how safety performance will be measured and monitored
  - Detailed outline for Communication Plan, including reportable accidents, management response, and independent reviews
- Safety accounted for 20% of proposal evaluation score
- RFP included “Guidance for Safety Aspects of Hydrogen Projects” for reference

# Controlled H2 Fleet & Infrastructure Solicitation: Teaming

- An automobile manufacturer and an energy company;
- A hydrogen supplier;
- A fuel cell supplier;
- Utility and/or gas company
- A fleet operator of vehicles (private, local, state, or federal fleets);
- System and component suppliers;
- Small businesses;
- Universities, educational, and outreach organizations;
- State, local, and federal governments.

**The automobile manufacturer or the energy company will be the prime**

# Successful Teams Announced

- Ford Motor Co./BP
- FC: Ballard
- Stations in
  - Detroit, MI
  - Orlando, FL
  - Sacramento, CA

- General Motors/Shell
- FC: GM
- Stations in
  - Washington, DC/Fort Belvoir, VA
  - Detroit, MI
  - New York, NY
  - Los Angeles, CA

- DaimlerChrysler/BP
- FC: Ballard
- Stations in
  - Los Angeles, CA
  - Detroit, MI
  - Sacramento, CA

- Texaco Energy Systems/Hyundai
- FC: UTC Fuel Cells
- Stations in
  - Chino, CA
  - Pomona, CA
  - UC Davis

- Air Products, Conoco-Phillips, Toyota, Honda, Nissan, BMW
- FC: UTC, others
- Stations in
  - Northern CA
  - Southern CA
  - Las Vegas, NV

# Data Collection
## Details Specified in RFP Statement of Objectives

- 8 tables
- Footnotes to clarify

**DRAFT**
FINAL CONTENT SUBJECT TO CHANGE

**APPENDIX A**

**Statement of Objectives**
**Controlled Hydrogen Fleet and Infrastructure Demonstration**

**A.1.0 Background**

The use of fuel cell technology with hydrogen as the energy carrier offers a viable option to reduce dependence on imported petroleum, develop domestic improve fuel efficiency while reducing greenhouse gas emissions, and provide a diverse source of energy feedstocks. It also offers the opportunity to embrace both transportation and electric generation sectors.

In November of 2002, Energy Secretary, Spencer Abraham, announced the *Energy Roadmap*, a document designed to ensure a more secure and cleaner energy future for America. The Roadmap provides a blueprint for the coordinated, long-term, public and private efforts required for hydrogen energy development. These requirements include:

- Improved fuel cell durability
- Decreased cost of fuel cell stack
- Enhanced infrastructure/vehicle systems integration
- Focused demonstrations to showcase vehicle/infrastructure capabilities
- Accelerated development of codes and standards
- Public policies to educate the public about hydrogen as a fuel

**A.3.0 Project performance measures**

Applicants shall provide summaries of the vehicle, site, and energy parameters, as well as energy production (optional) test plans. Tables 1 - 6 below and the accompanying narrative summarize the performance measures.

*A.3.1 Performance Measures*

**Table 1. Vehicle Performance Measures**

| Category | Performance Measure | Units | Baseline Benchmark (Current) | 2006 Performance Targets | 2008 Performance Targets | Comments |
|---|---|---|---|---|---|---|
| | | | | | | |
| Operations | Fuel Economy (a) | MPGGE * | 50 (fuel cell vehicle) | 50 | 60 | Use draft SAE J2572 and draft EPA fuel economy test procedures. Overall testing may include FTP75, HWYFE, |
| | R | | | | | |

**Table 6. –Data for Modeling and Evaluation of Component Development Program at DOE**

| Vehicle Component | Required Data | Comments |
|---|---|---|
| | | |
| Dynamometer Testing (a) | | |
| Fuel Cell Stack | 1. Stack voltage, current<br>2. Anode inlet and outlet temperature and pressure<br>3. Cathode inlet and outlet temperature and pressure<br>4. Hydrogen feed and recirculation rates<br>5. Cathode air feed rate<br>6. Humidification levels for cathode and anode feed gases | Data to be obtained on a continuous basis. |
| Fuel Cell System Balance-of-Plant | 1. Power consumption by<br>– air compressor or blower<br>– radiator/condenser fan(s)<br>– hydrogen recirculator<br>– coolant / water pump(s)<br>– any other electrical components<br>2. Make-up water (if any) | Same as above |
| Major Components | 1. Traction Inverter Motor (TIM)<br>– current, voltage, power in<br>– motor voltage, current, power in<br>– motor shaft power out | Same as above |

# Performance Measures
# Data Collected

- **Vehicle Performance Measures**
  - **Operations**
    - Fuel economy
    - Range
    - Vehicle refueling time
  - **Vehicle Fuel Cell Systems and Components**
    - Durability
    - Efficiency
    - H2 tank cycle life
  - **Performance**
    - Top speed, Acceleration
    - Gradeability
    - Minimum/maximum temperature
    - Cold drive-away
    - Emissions
  - **Safety**
    - Unplanned failures,
    - Fuel tank release,
    - Grounding, sensor, and passenger compartment alarm

# Performance Measures Data Collected

- Infrastructure Performance Measures
  - **Site**
    - Purity of hydrogen from storage tank
  - **Fueling System**
    - Durability
    - Hydrogen production and delivery, refueling rate
  - **Safety**
    - Release of hydrogen from fueling connector

- Fuel cell co-generation facility (Optional)
    - Cost of co-generation
    - Fuel cell durability
    - Electrical efficiency of fuel cell
  - **Safety**
    - Electrical overload
    - Ground short
    - Alarms

# Data Analysis Approach (Fuel Cell Vehicles)

A. Identify significant factors affecting vehicle performance from collected data
B. Provide processed data for development/verification of codes and standards
C. Measure progress compared to research technical targets (MYPP, solicitation targets)
D. Identify possible technical areas of future research within Program from results -- *technology gaps and research opportunities*

# Overview of Technology Validation Hydrogen Fuel Cell Vehicle Performance Analysis

Performance at multiple temperatures

Performance at multiple elevations

Acceleration & Gradeability

FC Component Efficiencies

Dyno Fuel Economy

On-Road Fuel Economy

Driving Range

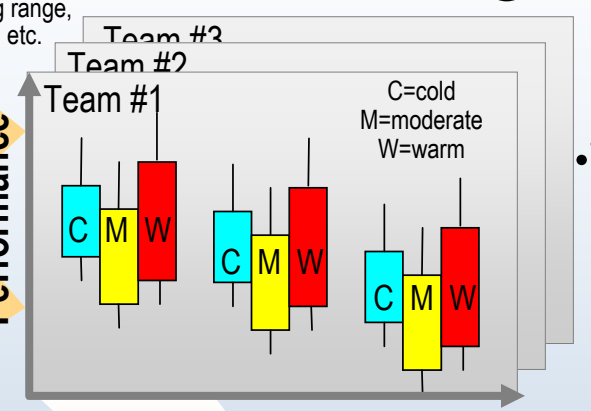
In-Use Data Acquisition System

Data Collected by Auto Teams

Compare Results from Multiple Climates & Technologies

Performance measures include vehicle fuel economy, driving range, acceleration, gradeability, etc.

A



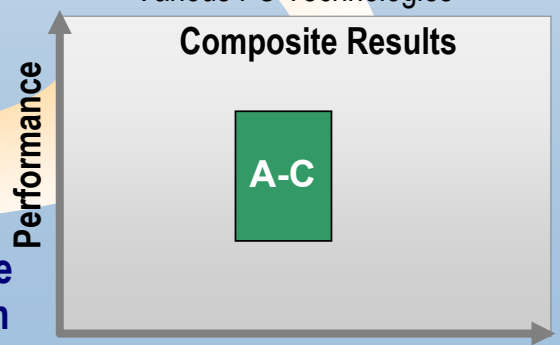

Firewall

B

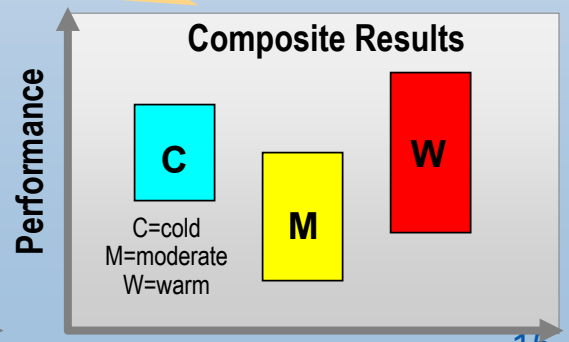
Results to Codes & Standards Groups

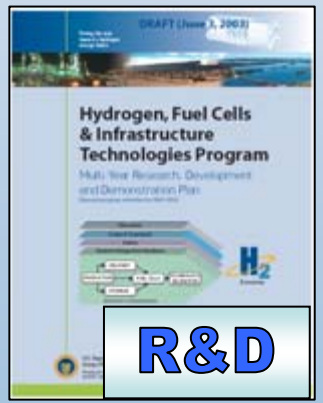
Summarize Results by Technology & Climate

Range of Performance for Various FC Technologies




Range of Performance for 3 climates




Re-Focus R&D as Appropriate

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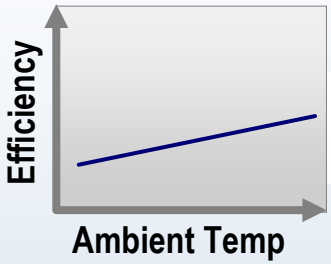
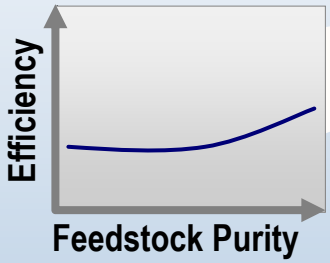
ADVISOR 2003

Compare Performance Against DOE Program Technical Targets

C

# Overview of Technology Validation Hydrogen Production Analysis



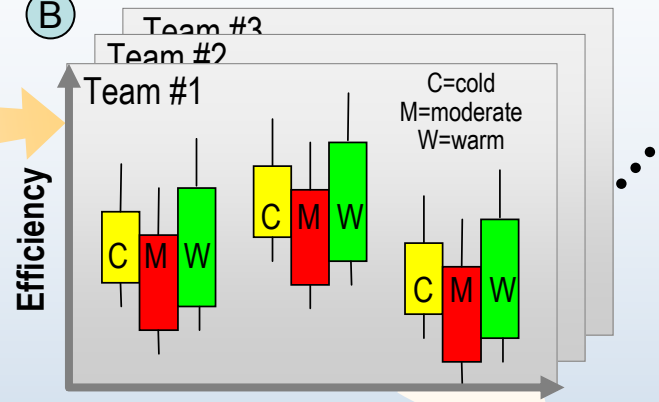

Detailed analyses of production data determine what factors affect productive efficiencies

A

Identify Factors Affecting Performance

Compare Results from Multiple Sites and Methods

B




Map Performance Against Program Technical Targets

C

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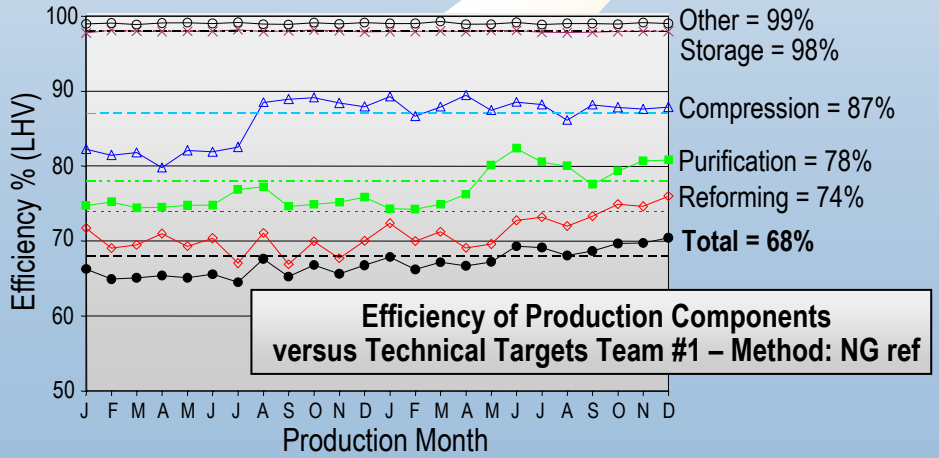
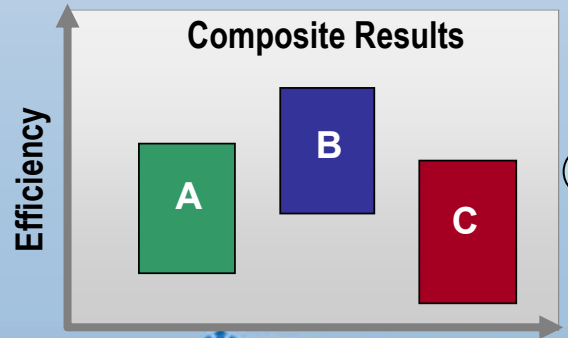
Summarize Results by Method




Efficiency of Production Components versus Technical Targets Team #1 – Method: NG ref

Range of Efficiency Achieved by Different Productive Methods

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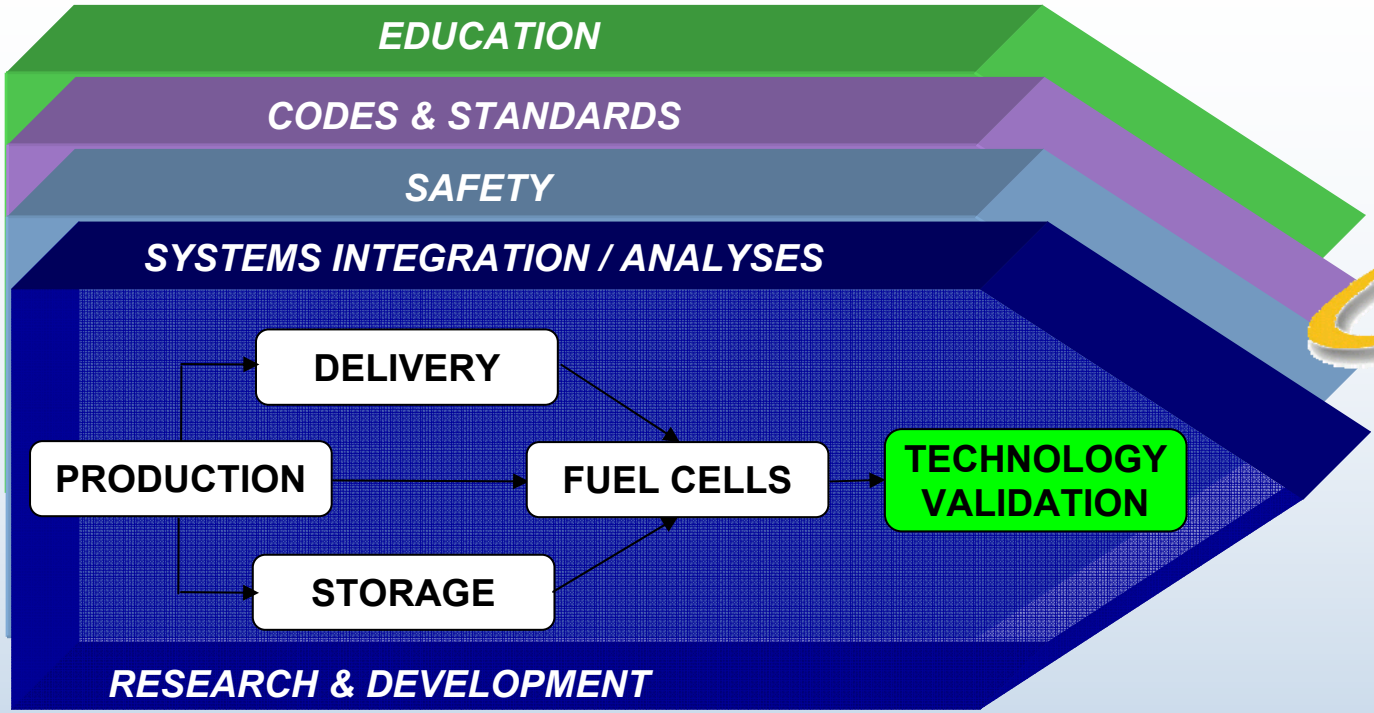
# Future Work
# Controlled H2 Fleet & Infrastructure Project

- Remainder 2004
  - Industry/government kick-off meetings
  - Discussions on data collection methods, codes and standards, and education
  - Begin quarterly Validation Assessment Reports
- 2005 and beyond
  - Complete *first generation* vehicle & infrastructure demonstration
  - Compare technical progress to program objectives
  - Actively feed findings from project back into HFCIT program R&D activities (“learning demonstration”)
  - Implement *second generation* systems to meet 2008 targets




Economy

# Questions?